We claim:

1. Apparatus for use in a pilot assisted channel estimation orthogonal frequency multiplexing system comprising:

an initial time and frequency synchronizer for setting time and frequency parameters of the apparatus as a function of a received signal containing pilot symbols;

a fast Fourier transformer;

a pilot extractor and channel estimator;

a controller that controls first and second phase rotators according to an output of the pilot extractor and channel estimator,

wherein the first phase rotator phase rotates an output of the initial time and frequency synchronizer for output to the fast Fourier transformer; and

wherein the second phase rotator phase rotates an output of the fast Fourier transformer for output to the pilot extractor and channel estimator and a receiver.

2. The apparatus of claim 1, wherein the time and frequency parameters are set such that intercarrier interference effects and intersymbol interference effects are negligible.

3. The apparatus of claim 1, wherein the received signal has plural carrier frequencies.

4. The apparatus of claim 1, wherein the setting of the parameters occurs in real time.

5. The apparatus of claim 1, wherein the initial time and frequency synchronizer uses discreet initial timing and frequency offsets.

6. The apparatus of claim 1, wherein:

the controller measures a phase difference between the output of the pilot extractor and channel estimator at times k and $k + \Delta k$, where k is time and Δk is a symbol period; and

the controller measures a phase difference between the output of the pilot extractor and channel estimator at frequencies n and $n + \Delta n$, where n is tone frequency and Δn is a frequency spacing between adjacent tones,

wherein the controller controls the first phase rotator as a function of the phase difference between the output of the pilot extractor and the channel estimator at times k and $k + \Delta k$; and

wherein the controller controls the second phase rotator as a function of the phase difference between the output of the pilot extractor and the channel estimator at frequencies n and $n + \Delta n$.

7. The apparatus of claim 1, wherein:

the first phase rotator phase rotates the output of the initial time and frequency synchronizer by $\exp(-j2k\theta_T)$, where k is the time and θ_T is a first output from the controller; and

the second phase rotator phase rotates an output of the fast Fourier transformer for output to the pilot extractor and channel estimator by $\exp(-j2n\theta_F)$, where n is the tone frequency and θ_F is a second output from the controller.

8. A method of synchronization for use in a pilot assisted channel estimation orthogonal frequency multiplexing system, the method comprising the steps of:

receiving a signal containing pilot symbols;

setting time and frequency parameters as a function of the signal so as to provide an initial time and frequency synchronization;

phase rotating the signal across time;

transforming the signal with a fast Fourier transformation;

phase rotating the signal across frequency; and

extracting the pilot symbols and generating a channel estimate from the signal after the signal has been phase rotated across frequency,

wherein the phase rotating across time and the phase rotating across frequency are controlled as a function of the channel estimate.

9. The method of claim 8, wherein the setting time and frequency parameters is done such that intercarrier interference effects and intersymbol interference effects are negligible.

10. The method of claim 8, wherein the signal containing pilot symbols has plural carrier frequencies.

11. The method of claim 10, wherein each of the plural carrier frequencies has an arrival timing offset and a frequency offset.

12. The method of claim 8, wherein the signal includes a time spread or Doppler spread.

13. The method of claim 8, wherein the setting time and frequency parameters occurs in real time.

14. The method of claim 8, wherein the initial time and frequency synchronizer uses discreet initial timing and frequency offsets.

15. The method of claim 8, wherein:

a first measure being measured by the phase rotation controller and phase rotating the signal across time as a function of the first measure, the first measure being a phase difference between the channel estimator at times k and $k + \Delta k$, where k is time and Δk is a symbol period;

a second measure being measured by the phase rotation controller and phase rotating the signal across frequency as a function of the second measure, the first measure being a phase difference between the channel estimator at frequencies n and $n + \Delta n$, where n is tone frequency and Δn is a frequency spacing between adjacent tones.

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16. The method of claim 8, wherein:

the phase rotating the signal across frequency introduces $\exp(-j2n\theta_F)$ of rotation, where n is the tone frequency and θ_F is a first control signal which is a function of the channel estimate; and

the phase rotating the signal across time introduces $\exp(-j2k\theta_T)$, where k is time and θ_T is a second control signal which is a function of the channel estimate.

17. A pilot assisted channel estimation orthogonal frequency multiplexing system comprising:

initial synchronization means for initial time and frequency setting time and frequency parameters of the system as a function of a received signal containing pilot symbols;

fast Fourier transform means for fast Fourier transforming the received signal;

extracting and estimating means for extracting pilots and providing a channel estimate;

controlling means for controlling a first and second phase rotations according to the channel estimate,

wherein the first phase rotation rotates an output of the initial synchronization means for output to the fast Fourier transform means; and

the second phase rotation rotates an output of the fast Fourier transform means for output to the extracting and estimating means and a receiver means for receiving the received signal.

18. The system of claim 17, wherein initial synchronization means sets the time and frequency parameters such that intercarrier interference effects and intersymbol interference effects are negligible.

19. The system of claim 17, wherein the signal containing pilot symbols has a plurality of carrier frequencies.

20. The system of claim 17, wherein the setting time and frequency parameters occurs in real time.

21. The system of claim 17, wherein the initial synchronization means uses discreet initial timing and frequency offsets.

22. The system of claim 17, wherein:

the controlling means measures a phase difference between an output of the extracting and estimating means at times k and k + Δk, where k is time and Δk is a symbol period; and

the controlling means measures a phase difference between the output of the extracting and estimating at frequencies n and n + Δn, where n is tone frequency and Δn is a frequency spacing between adjacent tones.

23. The system of claim 17, wherein:

the first phase rotation is by $\exp(-j2k\theta_T)$, where k is time and θ_T is set by the controlling means; and

the second phase rotation is by $\exp(-j2n\theta_F)$, where n is the tone frequency and θ_F is set by the controlling means.

24. A computer program in computer readable form for causing a processor executing the program to synchronize the sub-components of a received signal to each other, the program comprising:

a module for initially synchronizing a pilot containing signal so as to provide an initial time and frequency synchronization;

a module for phase rotating the signal across time;

a module for transforming the signal with a fast Fourier transformation;

a module for phase rotating the signal across frequency; and

a module for extracting the pilot symbols and generating a channel estimate from the signal after the signal has been phase rotated across frequency,

wherein the module for phase rotating across time and the module for phase rotating across frequency are responsive to the channel module for extracting and estimating.

25. The program of claim 24, wherein the initially synchronizing the signal so as to provide an initial time and frequency synchronization synchronizes the signal containing the pilot symbols such that intercarrier interference effects and intersymbol interference effects are negligible.

26. The program of claim 24, wherein the signal containing pilot symbols has plural carrier frequencies.

27. The program of claim 24, wherein the synchronizing of the signal by the processor loaded with a program occurs in real time.

28. The program of claim 24, wherein initial synchronization uses discreet initial timing and frequency offsets.

29. The program of claim 24, wherein:

the phase rotating across time controlled as a function of the with the channel estimate is controlled as a function of a calculated phase difference between the channel estimator at times k and k + Δk, where k is time and Δk is a symbol period; and

the phase rotating across frequency controlled as a function of the channel estimate is controlled as a function of a calculated phase difference between the channel estimator at frequencies n and n + Δn, where n is tone frequency and Δn is a frequency spacing between adjacent tones.

30. The program of claim 24, wherein:

the phase rotating the signal across frequency rotates the signal by $\exp(-j2n\theta_F)$, where n is the tone frequency and θ_F is set as a function of the channel estimate; and

the phase rotating the signal across time rotates the signal by $\exp(-j2k\theta_T)$, where k is time and θ_T is set as a function of the channel estimate.